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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/602,690	06/23/2000	Donald Brian Eidson	01827.0037.00US00	1643

7590 02/17/2004

HOWERY SIMON ARNOLD & WHITE, LLP  
301 Ravenswood Ave.  
Box 34  
Menlo Park, CA 94025

EXAMINER

CHAUDRY, MUJTABA M

ART UNIT	PAPER NUMBER
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2133

DATE MAILED: 02/17/2004

10

Please find below and/or attached an Office communication concerning this application or proceeding.

**Office Action Summary**

Application No.

09/602,690

Applicant(s)

EIDSON ET AL.

Examiner

Mujtaba K Chaudry

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --  
**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

- 1) ☒ Responsive to communication(s) filed on 23 June 2000.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

- 4) ☐ Claim(s) 1-51 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-42 and 48-51 is/are rejected.
- 7) ☒ Claim(s) 43-47 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

**Application Papers**

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 23 June 2000 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)                        | 4) <input type="checkbox"/> Interview Summary (PTO-413)                     |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948)               | Paper No(s)/Mail Date. _____  |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date <u>3,5,6,7,9</u> .   | 6) <input type="checkbox"/> Other: _____                                    |

## DETAILED ACTION

### *Drawings*

The drawings are objected to because:

#### **Figure 1A:**

- Figure 1A should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.
- Reference block 3 needs to be labeled.
- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 1A, reference numbers 1-5. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

#### **Figure 1B:**

- Figure 1B should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

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**Figure 1C:**

- Figure 1C should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.
- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 1C, reference number 15. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

**Figure 3A:**

- Reference block 26 needs to be labeled.
- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 3A, reference number 26. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

**Figure 3B:**

- Reference block 31 needs to be labeled.

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- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 3B, reference numbers 29a, 29b, 33 and 32. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

**Figure 4:**

- Reference block 37 needs to be labeled.

**Figure 5:**

- Reference block 42 needs to be labeled.
- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 5, reference numbers 41a, 41b, 41c, 39d and 43. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

**Figure 6:**

- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 6, reference number 52. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to

the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

**Figure 7:**

- Reference block needs to be labeled.

**Figure 8A:**

- Reference block needs to be labeled.

**Figure 9A:**

- Reference block needs to be labeled.

**Figures 9B, 10 and 16:**

- Figures are off center and need to be centered.

**Figure 11A:**

- Reference blocks 61a, 61b and 61c need to be labeled.

**Figure 11B:**

- Reference block 61 needs to be labeled.

**Figure 15:**

- The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference sign(s) not mentioned in the description: Figure 15, reference number 200. A proposed drawing correction, corrected drawings, or amendment to the specification to add the reference sign(s) in the description, are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

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A proposed drawing correction or corrected drawings are required in reply to the Office action to avoid abandonment of the application. The objection to the drawings will not be held in abeyance.

### *Specification*

The disclosure is objected to because of the following informalities:

- Applicant is reminded that reference numbers pointed out above in the drawing objections need to appear in the specification.

Appropriate correction is required.

### *Claim Objections*

Claim 2 is objected to under 37 CFR 1.75 as being a substantial duplicate of claim 3. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording. See MPEP § 706.03(k). Applicant is suggested to cancel either claim 2 or 3.

Claim 43 is objected to under 37 CFR 1.75(c) as being in improper form because of multiple dependency. See MPEP § 608.01(n). Claim 43 recites, “A system which comprises a transmitter including the SCTCM encoder of any of **claims 20 or 21, and one or more receivers each including the SCTCM decoder of claim 41**, the transmitter configured to broadcast information to the one or more receivers over a transmission link.” [Emphasis added]. The Applicants are advised to either restructure the claim language so that it only depends from

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one other claim or to cancel the present claim. As a note of reference, claims 44-46 depend from independent claim 43 and inherently include limitations therein and are objected to as well.

Furthermore the Examiner would like to point out that claims 43-46 will not be examined on the merits.

Claim 47 is objected to under 37 CFR 1.75(c) as being in improper form because of multiple dependency. See MPEP § 608.01(n). Claim 47 recites, "A system which comprises a transmitter including the SCCC encoder of **claim 22, and one or more receivers each including the SCCC decoder of claim 42**, the transmitter configured to broadcast information to the one or more receivers over a transmission link." [Emphasis added]. The Applicants are advised to either restructure the claim language so that it only depends from one other claim or to cancel the present claim. Furthermore the Examiner would like to point out that claim 47 will not be examined on the merits.

Claims 20-24, 41-43 and 47 is objected to because of the following informalities:

- In the abovementioned claims, the acronyms SCCC and/or SCTCM need to be spelled out.

Claim 38 is objected to because of the following informalities:

- Claim 38 recites, "*A method of performing TCM modulation comprising the following steps: providing a k-tuple of bits as an input to an outer encoder comprising a convolutional encoder having redundancy, the outer encoder producing an n-tuple of bits, where both n and k are integers and  $n > k$ ; passing the n-tuple of bits through an interleaver, which outputs an n-tuple of*



*interleaved bits; providing the n-tuple of interleaved bits as input to an inner encoder comprising the rate  $n/n$  encoder of claim 1; receiving an n-tuple of output bits from the inner encoder; and mapping the n-tuple of output bits into a D-dimensional channel symbol, where D is an integer greater than or equal to 1.*" The Examiner would like to point out that the dependency of the claim is not in the preamble. It is not clear if the Applicants had intended for this claim to be independent or dependent. As a suggestion, the Applicants are advised to move the dependency language "...encoder of claim 1..." in the preamble of the claim without changing the scope of the claim. Optionally, to make claim 38 independent, Applicants may incorporate all stated limitations of claim 1 into claim 38 without changing the scope of the claim.

Claim 39 is objected to because of the following informalities:

Claim 39 recites, "*A method of performing SCC modulation comprising the following steps: providing a k-tuple of bits as an input to an outer encoder comprising a convolutional encoder having redundancy, the outer encoder producing an n-tuple of bits, where both n and k are integers and  $n > k$ ; passing the n-tuple of bits through an interleaver, which outputs an n-tuple of interleaved bits; providing the n-tuple of interleaved bits as input to an inner encoder comprising the rate  $n/n$  encoder of claim 1; receiving an n-tuple of output bits from the inner encoder; and mapping the n-tuple of output bits into a QPSK or BPSK channel symbol.*" The Examiner would like to point out that the dependency of the claim is not in the preamble. It is not clear if the Applicants had intended for this claim to be independent or dependent. As a suggestion, the Applicants are advised to move the dependency language "...encoder of claim 1..." in the preamble of the claim without changing the scope of the claim. Optionally, to make claim 39 independent, Applicants

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may incorporate all stated limitations of claim 1 into claim 39 without changing the scope of the claim.

Appropriate correction is required.

### ***Claim Rejections - 35 USC § 112***

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

- The term "prime polynomial" in claim 1 is a relative term which renders the claim indefinite since it is not defined over any specific field. The term "prime polynomial" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably appraised of the scope of the invention. The Examiner would like to point out that the issue of indefiniteness arises because a "primitive polynomial" is defined over some field. The claim language does not specify a field. For example the polynomial  $x^2 + x + 1$  is irreducible in  $GF(2)[x]$ , but not in  $GF(4)[x]$ . Therefore, in order to overcome this issue, Applicants are advised to specify the field for the prime polynomial in the claim language.

Appropriate correction is required.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

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(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966),

that are applied for establishing a background for determining obviousness under 35

U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

Claims 1-42 and 48-51 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Turbo**

**Codes: Analysis, Design and Iterative Decoding and Applications** Course 909, by Benedetto

et al. further in view of Divsalar et al. (USPN 6023783). As stated above, due to multiple dependencies, claims 43-47 can not be examined on the merits.

As per claim 1, Benedetto et al. (herein after: Benedetto) substantially teaches the limitations in claim 1 of the present application through Figure 3, page 295; Figure 4, page 300 and Figure 8, page 339. Claim 1 of the present application recites: A rate  $n/n$  recursive, systematic convolutional encoder which comprises:  $n$  inputs, wherein  $n$  is an integer greater than 1;  $n$  parallel outputs; an adder having  $(n+1)$  inputs and an output; and a feedback loop, including one or more storage elements in series, coupled to the output of the adder and to an input thereof, the feedback loop and the one or more storage elements being characterized by a prime polynomial; wherein all  $n$  encoder inputs are input to the adder,  $(n-1)$  of the encoder inputs are

passed through unaltered to form  $(n-1)$  of the encoder outputs, and the  $n^{\text{th}}$  encoder output is derived from the feedback loop. The following figure is imported from Benedetto's reference.

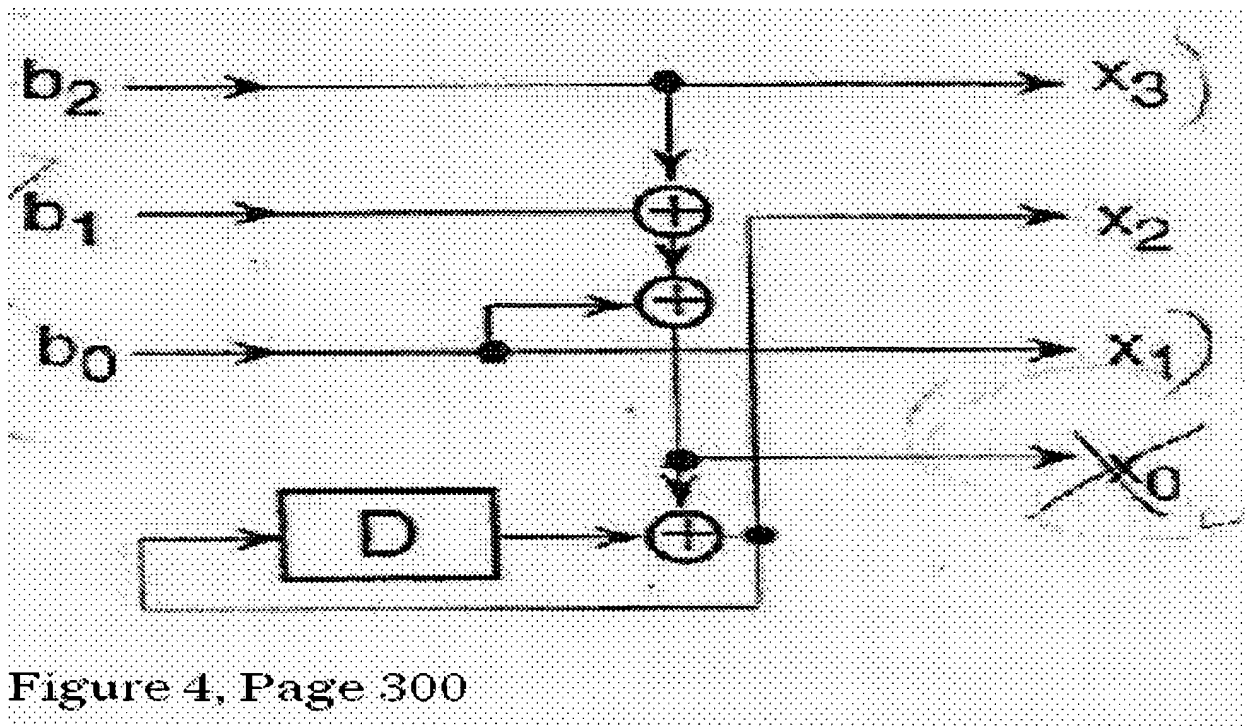


Figure 4, Page 300

The Examiner would like to point out that in the above Figure 4, Benedetto teaches the limitations of claim 1 with slight modification. The following description is in reference to Figure 4 above: The adder connected to the output of the delay element has  $(n+1)$  inputs, which are  $b_2$ ,  $b_1$ ,  $b_0$  and the output of the adder. The output of the adder is formed in a feedback loop that includes a storage element. Furthermore, two of the three inputs of the encoder are unaltered, namely  $b_2$  and  $b_0$ , whose respective outputs are  $x_3$  and  $x_1$ .

Benedetto does not explicitly teach a rate  $n/n$  encoder as stated in the present application. The Examiner would like to point out that it is well known in the art that a rate of an encoder is defined as the ratio of the number of inputs to outputs. The limitation of claim 1 of the present application states a rate  $n/n$ , which essentially means that the number of inputs is equal to the

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number of outputs. Referring to Benedetto's Figure 4 above, one of ordinary skill in the art at the time the invention was made would have recognized that by eliminating output x0 would indeed have made the above-shown encoder a rate  $n/n$ . This modification would have been obvious to one of ordinary skill in the art because one of ordinary skill in the art would have recognized that by eliminating the x0 output of the encoder taught by Benedetto in Figure 4 would have increased the coding gain at relatively low bit error rates. Furthermore, the Examiner would like to add that by removing the x0 output also would have been an obvious design choice and not patentably distinct.

As per claims 2-3, Benedetto substantially teaches, in view of above rejections and Figure 4 above, a feedback loop that includes a single storage element wherein the input of the storage element is coupled to the output of the adder, and the output of the storage element is coupled to an input of the adder, and the nth encoder output is derived from the output of the storage element.

As per claims 4-8 and 11-19, Benedetto substantially teaches, in view of above rejections, a rate  $n/n$  encoder which could be modified to a rate  $2/2$ ,  $3/3$ ,  $4/4$ ,  $5/5$  or greater. This is an engineering design choice which could easily be modified.

As per claims 9, 10 and 32-35, Divsalar et al. (herein after: Divsalar) in an analogous art teaches (title & abstract) several improved turbo code apparatuses and methods. The Divsalar patent encompasses several classes: A data source is applied to two or more encoders with an interleaver between the source and each of the second and subsequent encoders. Each encoder outputs a code element which may be transmitted or stored. A parallel decoder provides the ability to decode the code elements to derive the original source information without use of a

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received data signal corresponding to  $d$ . The output may be coupled to a multilevel trellis-coded modulator (TCM). A data source  $d$  is applied to two or more encoders with an interleaver between the source and each of the second and subsequent encoders. Each of the encoders outputs a code element. In addition, the original data source  $d$  is output from the encoder. All of the output elements are coupled to a TCM. At least two data sources are applied to two or more encoders with an interleaver between each source and each of the second and subsequent encoders. The output may be coupled to a TCM. At least two data sources are applied to two or more encoders with at least two interleavers between each source and each of the second and subsequent encoders. At least one data source is applied to one or more serially linked encoders through at least one interleaver. The output may be coupled to a TCM. The invention includes a novel way of terminating a turbo coder. In particular Divsalar substantially teaches (col. 22, lines 43-67), in view of above rejections, methods that are equivalent to a multidimensional trellis-coded modulation scheme that uses  $2^{\sup{b/2}} \cdot 2^{\sup{1+b/2}}$  symbols per branch, where the first symbol in the branch (which depends only on uncoded information) is punctured. With these methods, the reliability of the punctured symbols can be fully estimated at the decoder. The constituent codes for a given modulation could be redesigned based on the Euclidean distance. The first example is for  $b=2$  with 16 QAM modulation where, for simplicity, we can use the  $2/3$  codes in Table I above with Gray code mapping. Note that this may result in suboptimum constituent codes for multilevel modulation. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21.

As per claims 20-30, 36, 37 and 48-52, Divsalar substantially teaches (col. 22, lines 1-63), in view of above rejections, various embodiments for Trellis Code Modulation (TCM). For

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example, for a  $q=2$  turbo code with rate  $b/(b+1)$  constituent encoders, select the  $b/2$  systematic outputs and puncture the rest of the systematic outputs, but keep the parity bit of the  $b/(b+1)$  code (note that the rate  $b/(b+1)$  code may have been obtained already by puncturing a rate  $1/2$  code). Then do the same to the second constituent code, but select only those systematic bits that were punctured in the first encoder. This method requires at least two interleavers: the first interleaver permutes the bits selected by the first encoder and the second interleaver permutes those bits punctured by the first encoder. For MPSK (or M-QAM), we can use  $2^{\lceil 1+b/2 \rceil}$  PSK symbols (or  $2^{\lceil 1+b/2 \rceil}$  QAM symbols) per encoder and achieve throughput of  $b/2$ . For M-QAM, we can also use  $2^{\lceil 1+b/2 \rceil}$  levels in the I-channel and  $2^{\lceil 1+b/2 \rceil}$  levels in the Q-channel and achieve a throughput of  $b$  bits/s/Hz. These methods are equivalent to a multidimensional trellis-coded modulation scheme (in this case, two multilevel symbols per branch) that uses  $2^{\lceil b/2 \rceil} \cdot 2^{\lceil 1+b/2 \rceil}$  symbols per branch, where the first symbol in the branch (which depends only on uncoded information) is punctured. Now, with these methods, the reliability of the punctured symbols can be fully estimated at the decoder. The constituent codes for a given modulation should be redesigned based on the Euclidean distance. The first example is for  $b=2$  with 16 QAM modulation where, for simplicity, we can use the  $2/3$  codes in Table I above with Gray code mapping. Note that this may result in suboptimum constituent codes for multilevel modulation. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21. The BER performance of this code with the turbo decoding structure for two codes discussed above is given in FIG. 22. For permutations  $\pi_{sub.1}$  and  $\pi_{sub.2}$ , we used S-random permutations with  $S=40$  and  $S=32$ , with a block size of 16,384 bits. Throughput was 2 bits/s/Hz. For 8 PSK modulation, we used two 16-state, rate  $4/5$  codes given above to achieve a

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throughput of 2 bits/s/Hz. The parallel concatenated trellis codes with 8 PSK and two clock-cycle trellis termination is shown in FIG. 23. The BER performance of this code is given in FIG. 24. For 64 QAM modulation, two 16-state were used, rate 4/5 codes given above to achieve a throughput of 4 bits/s/Hz. The parallel concatenated trellis codes with 64 QAM and two clock-cycle trellis termination is shown in FIG. 25. The BER performance of this code is given in FIG. 26. For 8 PSK modulation, we used two 16-state, rate 4/5 codes given above to achieve a throughput of 2 bits/s/Hz. The parallel concatenated trellis codes with 8 PSK and two clock-cycle trellis termination is shown in FIG. 23. The BER performance of this code is given in FIG. 24. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21. FIG. 23 is a block diagram of an 8 PSK turbo trellis-coded modulation coder in accordance with the present invention. The Examiner would like to point out that with the combination of the teachings of Divsalar with Benedetto the various embodiments of the above claims are established.

As per claims 31 and 38-42, Divsalar substantially teaches (col. 22, lines 1-63), in view of above rejections, various embodiments for Trellis Code Modulation (TCM). Divsalar teaches FIG. 28, a block diagram showing a general iterative decoder structure for the TCM encoded output of, for example, FIGS. 21, 23, and 25. Furthermore, Divsalar teaches a method to construct Turbo TCM. As stated before, for a  $q=2$  turbo code with rate  $b/(b+1)$  constituent encoders, select the  $b/2$  systematic outputs and puncture the rest of the systematic outputs, but keep the parity bit of the  $b/(b+1)$  code (note that the rate  $b/(b+1)$  code may have been obtained already by puncturing a rate  $1/2$  code). Then do the same to the second constituent code, but select only those systematic bits that were punctured in the first encoder. This method requires



at least two interleavers: the first interleaver permutes the bits selected by the first encoder and the second interleaver permutes those bits punctured by the first encoder. For MPSK (or M-QAM), we can use  $2^{\lceil 1+b/2 \rceil}$  PSK symbols (or  $2^{\lceil 1+b/2 \rceil}$  QAM symbols) per encoder and achieve throughput of  $b/2$ . For M-QAM, we can also use  $2^{\lceil 1+b/2 \rceil}$  levels in the I-channel and  $2^{\lceil 1+b/2 \rceil}$  levels in the Q-channel and achieve a throughput of  $b$  bits/s/Hz. These methods are equivalent to a multidimensional trellis-coded modulation scheme (in this case, two multilevel symbols per branch) that uses  $2^{\lceil b/2 \rceil} \cdot 2^{\lceil 1+b/2 \rceil}$  symbols per branch, where the first symbol in the branch (which depends only on uncoded information) is punctured. Now, with these methods, the reliability of the punctured symbols can be fully estimated at the decoder. Obviously, the constituent codes for a given modulation should be redesigned based on the Euclidean distance. The first example is for  $b=2$  with 16 QAM modulation where, for simplicity, we can use the  $2/3$  codes in Table I above with Gray code mapping. Note that this may result in suboptimum constituent codes for multilevel modulation. A turbo encoder with 16 QAM and two clock-cycle trellis termination is shown in FIG. 21. The BER performance of this code with the turbo decoding structure for two codes discussed above is given in FIG. 22. For permutations  $\pi_{1,1}$  and  $\pi_{1,2}$ , we used S-random permutations with  $S=40$  and  $S=32$ , with a block size of 16,384 bits. Throughput was 2 bits/s/Hz. For 8 PSK modulation, we used two 16-state, rate  $4/5$  codes given above to achieve a throughput of 2 bits/s/Hz. The parallel concatenated trellis codes with 8 PSK and two clock-cycle trellis termination is shown in FIG. 23. The BER performance of this code is given in FIG. 24. For 64 QAM modulation, we used two 16-state, rate  $4/5$  codes given above to achieve a throughput of 4 bits/s/Hz. The parallel concatenated trellis codes with 64 QAM and two clock-cycle trellis

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termination is shown in FIG. 25. The BER performance of this code is given in FIG. 26. In FIG. 27, Divsalar teaches a application of a TCM module M in combination with a conventional two-code turbo coder to give the advantages noted above. In addition, such a module M is shown in outline in FIGS. 6 and 7. It should be noted that the structures shown in FIGS. 6, 7, and 27 are general in nature, and provide advantages independent of specific interleavers, coders, and TCM modules.

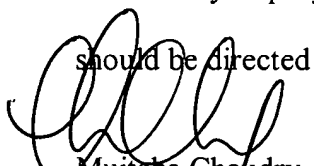
### ***Conclusion***

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Benedetto and Divsalar in combination substantially teach the limitations of the present application. As a note, only Divsalar is included in the PTO 892 since Applicants submitted Benedetto in their IDS and therefore shall have the original copy.

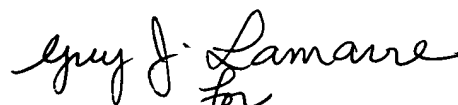
Any inquiries concerning this communication should be directed to the examiner, Mujtaba Chaudry who may be reached at 703-305-7755. The examiner may normally be reached Mon – Thur 7:30 am to 4:30 pm and every other Fri 8:00 am to 4:00 pm.

If attempts to reach the examiner by telephone are unsuccessful, please contact the examiner's supervisor, Albert DeCady at 703-305-9595. The fax phone number for the organization where this application is assigned is 703-746-7239.

Any inquiry of general nature or relating to the status of this application or proceeding should be directed to the receptionist at 703-305-3900.



Mujtaba Chaudry  
Art Unit 2133  
February 11, 2004



Albert DeCady  
Primary Examiner